Page 19, line 30, after "with" insert - - the circuit element 30 where - -; and after "period" insert a comma (,).

Page 26, line 1, delete the underline and make all upper case -- ABSTRACT OF THE DISCLOSURE: --.

Page 26, lines 2 and 3, delete the title.

In the Claims:

Amend the claims 1-23, and add new claim 24 as follows.

1.(Amended) An apparatus for detecting the phase and amplitude of electromagnetic waves, preferably in the optical and in the near infrared and ultraviolet range, comprising at least two modulation photogates (1, 2) which are sensitive to the electromagnetic waves (photosensitive) and accumulation gates (4, 5) which are associated with the modulation photogates said accumulation gates (4,5) being neither [and which are not] photosensitive nor shaded, and electrical connections for the modulation photogates (1, 2) and the accumulation gates (4, 5) so that the latter can be connected to a reading-out device and the former can be connected to a modulating device which increases or reduces the potential of the modulation photogates (1, 2) relative to each other and relative to the preferably constant potential of the accumulation gates (4, 5) corresponding to a desired modulation function, characterised in that there are provided a plurality of modulation photogates (1, 2) and accumulation gates (4, 5) in the form of long narrow parallel strips which group-wise form a PMD-pixel, wherein the accumulation gates are in the form of reading-out diodes with preferably in each case the cathode as the reading-out electrode.

2.(Amended) An apparatus for detecting the phase and amplitude of electromagnetic waves, preferably in the optical and in the near infrared and ultraviolet range, comprising at least two modulation photogates (1, 2) which are sensitive to the electromagnetic waves

(photosensitive) and accumulation gates (4, 5) which are associated with the modulation photogates and which are not photosensitive or shaded, and electrical connections for the modulation photogates (1, 2) and the accumulation gates (4, 5) so that the latter can be connected to a reading-out device and the former can be connected to a modulating device which increases or reduces the potential of the modulation photogates (1, 2) relative to each other and relative to the preferably constant potential of the accumulation gates (4, 5) corresponding to a desired modulation function, characterized in that there are provided a plurality of modulation photogates (1, 2) and accumulation gates (4, 5) in the form of long narrow parallel strips which group-wise form a PMD-pixel, wherein the accumulation gates are in the form of reading-out diodes with preferably in each case the cathode as the reading-out electrode, [Apparatus as set forth in claim 1] characteri[s]zed in that the width of the modulation photogates is greater than the width of the accumulation gates.

Cont D1

3.(Amended) Apparatus as set forth in claim [1 or claim] 2 characteri[s]zed in that the width of the individual modulation photogates is of the order of magnitude of the wavelength or in particular for the remote infrared range also less than the wavelength of the electromagnetic radiation to which the modulation photogates are sensitive.

4. (Twice Amended) Apparatus as set forth in one of claims [1] 2 through [2] 3 characteri[s]zed in that the strip length of the modulation photogates (1, 2) and the accumulation gates (4, 5) is more than ten times and preferably more than fifty times the wavelength of the electromagnetic radiation to which the modulation photogates are sensitive.

5. (Twice Amended) Apparatus as set forth in one of claims [1] 2 through] [2] 3 characteri[s]zed in that there are provided a plurality of modulation photogates in paired parallel mutually juxtaposed relationship, wherein each of the modulation photogates (1, 2) of such a pair is

connected to another modulation connection so that the modulation photogates (1, 2) are modulatable in push-pull relationship, wherein a respective accumulation gate (5, 4) is arranged between a pair of modulation photogates (1, 2) and a next adjacent further pair of modulation photogates (2, 1) and wherein the modulation photogates (1, 2) of the two pairs, which are immediately adjacent to a respective accumulation photogate (4, 5), are connected or electrically joined to the modulation connections in such a way that their modulation occurs respectively in push-pull mode.

Cont D1

6. (Twice Amended) Apparatus as set forth in one of claims [1] 2 through [2] 3 characteri[s]zed in that a plurality of modulation connections (m_1, m_2, m_3) are arranged at substantially equal spacings along the length of the strips and are connected to the modulation photogates (1, 2).

7. (Twice Amended) Apparatus as set forth in one of claims [1] 2 through [2] 3 characteri[s]zed in that the modulation photogates immediately adjoining the accumulation gates (4, 5), on the side towards the accumulation gates, partially involve a covering by a contacting strip of high conductivity and of no or very low transparency for the electromagnetic waves.

8. (Twice Amended) Apparatus as set forth in one of claims [1] 2 through [2] 3 characteri[s]zed in that the apparatus has one or more pixel elements, wherein a pixel element comprises a plurality of pairs of modulation gates (l, 2) and accumulation gates (4, 5), wherein the strip directions of adjacent pixel elements at different modulation voltages are preferably perpendicular to each other and wherein transversely with respect to the strip direction the ends of the pixels are defined by at least one respective modulation photogate (1, 2) which adjoins a next inwardly disposed accumulation gate (4, 5).

9. (Amended) Apparatus as set forth in claim 8 characteri[s]zed in that the accumulation gate connections are provided at a respective end of the strips of a pixel, wherein each second accumulation gate is connected to a respective one of two reading-out lines (for example K+) and the other accumulation gates are connected to the respective other one of the connection lines (corresponding to K-), wherein the reading-out lines lead to an evaluation circuit.

Cont D1

10. (Twice Amended) Apparatus as set forth in claim 8 characteri[s]zed in that two pixel elements (10, 10') are arranged with their strips parallel and in directly mutually juxtaposed relationship so that the mutually immediately adjacent modulation photogates which define the mutually juxtaposed ends or sides of the two pixel elements (10, 10') form a pair of modulation photogates (I, 2) which are modulatable selectively in push-pull mode or phase-displaced relationship, whereby either a single pixel element of double the size is formed or two independent measurement procedures, for example of an in-phase signal and a quadrature signal, are possible with the two pixel elements.

11. (Twice Amended) Apparatus as set forth in claim 8 characteri[s]zed in that four pixel elements are arranged in a rectangle, wherein the strips of the pixels which are disposed in diagonally opposite relationship in the rectangle respectively extend parallel to each other while the strips of the immediately adjacent pixel elements extend perpendicularly to each other, and wherein the modulation connections are connected in such a way that modulation of adjacent pixel elements (10) can be effected in phase-shifted relationship, more specifically preferably through 90° in each case.

12. (Amended) Apparatus as set forth in claim [9] 11 characteri[s]zed in that each of the pixel elements (10) is respectively of a substantially square shape and the four pixel

elements are assembled to form a square or that the corners are additionally cut off in such a way that substantially an octahedron shape is formed.

13. (Amended) Apparatus as set forth in claim 12 characteri[s]zed in that the four pixel elements are selectively combined individually (4-quadrant operation) or doubly in diagonal relationship (2-quadrant operation) or in quadruple relationship (1-quadrant operation), wherein in the case of 4quadrant operation and 2-quadrant operation the gradient or normal vector of the surface element is additionally evaluated.

Cont D1

14. (Twice Amended) Apparatus as set forth in claim 2 characteri[s]zed in that the modulation photogates and the accumulation gates and the associated signal evaluation peripheral equipment and modulation peripheral equipment are produced in part on-chip and in part as a multi-chip module using CMOS-technology or BICMOS-technology.

15. (Twice Amended) Apparatus as set forth in claim 2 characteri[s]zed in that arranged over the modulation photogates (1, 2) are strip lenses which focus substantially all the light incident on the surface of a 'pixel element exclusively on to the modulation photogates (1, 2).

16. (Twice Amended) Apparatus as set forth in claim 2 characteri[s]zed in that a plurality of PMD-pixels are arranged in a linear or matrix array.

17. (Twice Amended) Apparatus as set forth in claim 2 characteri[s]zed in that in a linear or matrix array both PMD-pixels with 3D-functionality and also conventional CMOS-pixels with 2D-functionality are used in mixed mode, wherein the various and in particular adjacent items of

pixel information are passed to a data-fusioning and interpolating device for reconstruction of the depth image.

18. (Twice Amended) Apparatus as set forth in claim [16] 17 characteri[s]zed in that preferably there is associated with each said PMD-pixel a microlens which concentrates the light incident on the array substantially on to the photosensitive surface of the individual pixels.

Cont D1

19. (Twice Amended) Use of an apparatus as set forth in claim [1] 2 characteri[s]zed in that the apparatus is used as a photosensitive image-recording element in a camera.

20. (Twice Amended) Use of the apparatus as set forth in claim [1] 2 characteri[s]zed in that the apparatus is used in optical signal processing as a frequency- and phase-sensitive mixing or correlation element for signal acquisition, processing and noise suppression.

21. (Twice Amended) A method of operating an apparatus as set forth in claim [1] 8 characteri[s]zed in that a scene of which an image is to be produced is illuminated with a light modulated in accordance with a modulation function, wherein the modulation photogates (1, 2) are modulated with the same but now bipolar or push-pull modulation function and wherein selectively for half of a 2-quadrant or 4-quadrant pixel of the pixels 90° phase-shifted modulation is effected in the case of sine modulation or a bit width in the case of rectangular modulation or a chip width in the case of PN-modulation of the modulation photogate voltages.

22. (Twice Amended) Use of an apparatus as set forth in claim [1] 2 characteri[s]zed in that the apparatus is used in an optical PLL-circuit or DLL-circuit which is preferably highly integrated and is preferably used in light barrier arrangements, as a PLL-array in

time lapse cameras, in optical remote controls and in data light barrier arrangements and for the regeneration of data signals in optical communications with various modulation modes.

23. (Twice Amended) Use of an apparatus as set forth in one of claims [1 and] 2 and 3 characteri[s]zed in that the apparatus is used in an optical PLL- or DLL-circuit with a 2Q-PMD-DLL on the basis of an IQ-PMD-receiver, in particular with PN-modulation, wherein digital PN-encoded data signals are used for multi-channel selection, multi-target detection and for highest sensitivity in phase transit time resolution, wherein the difference output voltage is formed as the difference of the quantitative differences of the photocurrents as U_{Δ} = const · ($|i_a - i_b|$ - $|i_c - i_d|$) and is fed back by way of a loop filter or a digital regulator as a control parameter of the voltage-controlled multivibrator to the chip frequency and wherein the data signal of the PN-encoded 1/0-data sequence is regenerated by means of the recovered word clock by a procedure whereby in the summing amplifier (41) the sum of the differences of the photocurrents U_{Σ} = const · ($|i_a - i_b|$) - ($|i_c - i_d|$) is respectively formed over a PN-word length by means of a short-term integrator contained in the summing amplifier.

24. (New) Apparatus as set forth in claim 16 characterized in that preferably there is associated with each said PMD-pixel a microlens which concentrates the light incident on the array substantially on to the photosensitive surface of the individual pixels.

Clean copies of these claims are attached hereto pursuant to 37 CFR 1.121.

Clean copy of claims 1-24:

1.(Amended) An apparatus for detecting the phase and amplitude of electromagnetic waves, preferably in the optical and in the near infrared and ultraviolet range, comprising at least two modulation photogates (1, 2) which are sensitive to the electromagnetic waves (photosensitive) and accumulation gates (4, 5) which are associated with the modulation photogates said accumulation gates (4,5) being neither photosensitive nor shaded, and electrical connections for the modulation photogates (1, 2) and the accumulation gates (4, 5) so that the latter can be connected to a reading-out device and the former can be connected to a modulating device which increases or reduces the potential of the modulation photogates (1, 2) relative to each other and relative to the preferably constant potential of the accumulation gates (4, 5) corresponding to a desired modulation function, characterised in that there are provided a plurality of modulation photogates (1, 2) and accumulation gates (4, 5) in the form of long narrow parallel strips which group-wise form a PMD-pixel, wherein the accumulation gates are in the form of reading-out diodes with preferably in each case the cathode as the reading-out electrode.

2.(Amended) An apparatus for detecting the phase and amplitude of electromagnetic waves, preferably in the optical and in the near infrared and ultraviolet range, comprising at least two modulation photogates (1, 2) which are sensitive to the electromagnetic waves (photosensitive) and accumulation gates (4, 5) which are associated with the modulation photogates and which are not photosensitive or shaded, and electrical connections for the modulation photogates (1, 2) and the accumulation gates (4, 5) so that the latter can be connected to a reading-out device and the former can be connected to a modulating device which increases or reduces the potential of the modulation photogates (1, 2) relative to each

other and relative to the preferably constant potential of the accumulation gates (4, 5) corresponding to a desired modulation function, characterized in that there are provided a plurality of modulation photogates (1, 2) and accumulation gates (4, 5) in the form of long narrow parallel strips which group-wise form a PMD-pixel, wherein the accumulation gates are in the form of reading-out diodes with preferably in each case the cathode as the reading-out electrode, characterized in that the width of the modulation photogates is greater than the width of the accumulation gates.

Cont'd

3.(Amended) Apparatus as set forth in claim 2 characterized in that the width of the individual modulation photogates is of the order of magnitude of the wavelength or in particular for the remote infrared range also less than the wavelength of the electromagnetic radiation to which the modulation photogates are sensitive.

4. (Twice Amended) Apparatus as set forth in one of claims 2 through 3 characterized in that the strip length of the modulation photogates (1, 2) and the accumulation gates (4, 5) is more than ten times and preferably more than fifty times the wavelength of the electromagnetic radiation to which the modulation photogates are sensitive.

5. (Twice Amended) Apparatus as set forth in one of claims 2 through] 3 characterized in that there are provided a plurality of modulation photogates in paired parallel mutually juxtaposed relationship, wherein each of the modulation photogates (1, 2) of such a pair is connected to another modulation connection so that the modulation photogates (1, 2) are modulatable in push-pull relationship, wherein a respective accumulation gate (5, 4) is arranged between a pair of modulation photogates (1, 2) and a next adjacent further pair of modulation photogates (2, 1) and wherein the modulation photogates (1, 2) of the two pairs, which are immediately adjacent to a respective accumulation photogate (4, 5), are connected or electrically joined to the

modulation connections in such a way that their modulation occurs respectively in push-pull mode.

6. (Twice Amended) Apparatus as set forth in one of claims 2 through 3 characterized in that a plurality of modulation connections (m_1, m_2, m_3) are arranged at substantially equal spacings along the length of the strips and are connected to the modulation photogates (1, 2).

Cont'd

7. (Twice Amended) Apparatus as set forth in one of claims 2 through 3 characterized in that the modulation photogates immediately adjoining the accumulation gates (4, 5), on the side towards the accumulation gates, partially involve a covering by a contacting strip of high conductivity and of no or very low transparency for the electromagnetic waves.

8. (Twice Amended) Apparatus as set forth in one of claims 2 through 3 characterized in that the apparatus has one or more pixel elements, wherein a pixel element comprises a plurality of pairs of modulation gates (I, 2) and accumulation gates (4, 5), wherein the strip directions of adjacent pixel elements at different modulation voltages are preferably perpendicular to each other and wherein transversely with respect to the strip direction the ends of the pixels are defined by at least one respective modulation photogate (1, 2) which adjoins a next inwardly disposed accumulation gate (4, 5).

9. (Amended) Apparatus as set forth in claim 8 characterized in that the accumulation gate connections are provided at a respective end of the strips of a pixel, wherein each second accumulation gate is connected to a respective one of two reading-out lines (for example K+) and the other accumulation gates are connected to the respective other one of the connection lines (corresponding to K-), wherein the reading-out lines lead to an evaluation circuit.

10. (Twice Amended) Apparatus as set forth in claim 8 characterized in that two pixel elements (10, 10') are arranged with their strips parallel and in directly mutually juxtaposed relationship so that the mutually immediately adjacent modulation photogates which define the mutually juxtaposed ends or sides of the two pixel elements (10, 10') form a pair of modulation photogates (I, 2) which are modulatable selectively in push-pull mode or phase-displaced relationship, whereby either a single pixel element of double the size is formed or two independent measurement procedures, for example of an in-phase signal and a quadrature signal, are possible with the two pixel elements.

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11. (Twice Amended) Apparatus as set forth in claim 8 characterized in that four pixel elements are arranged in a rectangle, wherein the strips of the pixels which are disposed in diagonally opposite relationship in the rectangle respectively extend parallel to each other while the strips of the immediately adjacent pixel elements extend perpendicularly to each other, and wherein the modulation connections are connected in such a way that modulation of adjacent pixel elements (10) can be effected in phase-shifted relationship, more specifically preferably through 90° in each case.

12. (Amended) Apparatus as set forth in claim 11 characterized in that each of the pixel elements (10) is respectively of a substantially square shape and the four pixel elements are assembled to form a square or that the corners are additionally cut off in such a way that substantially an octahedron shape is formed.

13. (Amended) Apparatus as set forth in claim 12 characterized in that the four pixel elements are selectively combined individually (4-quadrant operation) or doubly in diagonal relationship (2-quadrant operation) or in quadruple relationship (1-quadrant

operation), wherein in the case of 4quadrant operation and 2-quadrant operation the gradient or normal vector of the surface element is additionally evaluated.

14. (Twice Amended) Apparatus as set forth in claim 2 characterized in that the modulation photogates and the accumulation gates and the associated signal evaluation peripheral equipment and modulation peripheral equipment are produced in part on-chip and in part as a multi-chip module using CMOS-technology or BICMOS-technology.

Cont. B7

15. (Twice Amended) Apparatus as set forth in claim 2 characterized in that arranged over the modulation photogates (1, 2) are strip lenses which focus substantially all the light incident on the surface of a 'pixel element exclusively on to the modulation photogates (1, 2).

16. (Twice Amended) Apparatus as set forth in claim 2 characterized in that a plurality of PMD-pixels are arranged in a linear or matrix array.

17. (Twice Amended) Apparatus as set forth in claim 2 characterized in that in a linear or matrix array both PMD-pixels with 3D-functionality and also conventional CMOS-pixels with 2D-functionality are used in mixed mode, wherein the various and in particular adjacent items of pixel information are passed to a data-fusioning and interpolating device for reconstruction of the depth image.

18. (Twice Amended) Apparatus as set forth in claim 17 characterized in that preferably there is associated with each said PMD-pixel a microlens which concentrates the light incident on the array substantially on to the photosensitive surface of the individual pixels.

19. (Twice Amended) Use of an apparatus as set forth in claim 2 characterized in that the apparatus is used as a photosensitive image-recording element in a camera.

20. (Twice Amended) Use of the apparatus as set forth in claim 2 characterized in that the apparatus is used in optical signal processing as a frequency- and phase-sensitive mixing or correlation element for signal acquisition, processing and noise suppression.

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21. (Twice Amended) A method of operating an apparatus as set forth in claim 8 characterized in that a scene of which an image is to be produced is illuminated with a light modulated in accordance with a modulation function, wherein the modulation photogates (1, 2) are modulated with the same but now bipolar or push-pull modulation function and wherein selectively for half of a 2-quadrant or 4-quadrant pixel of the pixels 90° phase-shifted modulation is effected in the case of sine modulation or a bit width in the case of rectangular modulation or a chip width in the case of PN-modulation of the modulation photogate voltages.

22. (Twice Amended) Use of an apparatus as set forth in claim 2 characterized in that the apparatus is used in an optical PLL-circuit or DLL-circuit which is preferably highly integrated and is preferably used in light barrier arrangements, as a PLL-array in time lapse cameras, in optical remote controls and in data light barrier arrangements and for the regeneration of data signals in optical communications with various modulation modes.

23. (Twice Amended) Use of an apparatus as set forth in one of claims 2 and 3 characterized in that the apparatus is used in an optical PLL- or DLL-circuit with a 2Q-PMD-DLL on the basis of an IQ-PMD-receiver, in particular with PN-modulation, wherein digital PN-encoded data signals are used for multi-channel selection, multi-target

detection and for highest sensitivity in phase transit time resolution, wherein the difference output voltage is formed as the difference of the quantitative differences of the photocurrents as U_{Δ} = const · ($|i_a - i_b|$ - $|i_c - i_d|$) and is fed back by way of a loop filter or a digital regulator as a control parameter of the voltage-controlled multivibrator to the chip frequency and wherein the data signal of the PN-encoded 1/0-data sequence is regenerated by means of the recovered word clock by a procedure whereby in the summing amplifier (41) the sum of the differences of the photocurrents U_{Σ} = const · ($|i_a - i_b|$) - ($|i_c - i_d|$) is respectively formed over a PN-word length by means of a short-term integrator contained in the summing amplifier.

24.(New) Apparatus as set forth in claim 16 characterized in that preferably there is associated with each said PMD-pixel a microlens which concentrates the light incident on the array substantially on to the photosensitive surface of the individual pixels.